Catchment S-3 consists mainly of large lot (each about three acres) residential development. Much of the development has gravel roadways with grassed roadside swales. The overall percentage imperviousness for this type of development is on the order of 10 to 15 percent. This is low compared to a 40 to 45 percent imperviousness expected in a "typical" residential development. In general, it appears that the natural drainageways in the development have been respected. Photograph 3 shows a drainageway in catchment S-3. Development of the area has not caused significant stormwater impacts on the downstream channel reaches.

Photograph 2. Stream channel immediately upstream of 40th Street in the S-2 catchment. Riparian vegetation has been removed for agricultural development.

The channels in the S-3 watershed show little degradation in the reaches upstream of 40th Street. There is increased degradation, as shown by vertical channel incision in the lower portions of the

S-2 watershed. There was no flowing water in any of the channels at the time of the September or October 2000 site visits. There was a small area with standing water.

Photograph 3. Drainageway in Catchment S-3 adjacent to Rokeby Road.

The majority of the N-watershed has agricultural development or is undeveloped. The far western fringe of the N-4 catchment is currently undergoing development. A portion of the N-1 catchment (adjacent to the Interstate 80–U.S. Highway 77 interchange) has commercial development.

Many of the stream channels in the N-watershed show moderate to severe degradation. The degradation is manifested as vertical incision of the channels and accompanying sloughing of the channel banks. In many cases, the degradation appears to be due to historic stream channelization or placement of culverts.

There are few defined channels in the N-1 catchment. The channel that crosses Interstate 80 just west of U.S. Highway 77 has been heavily modified by commercial development adjacent to the interchange. The remainder of the channels in the area are small and do not show significant degradation.

The N-2, N-3 and N-5 catchments have agricultural development. The channels in these catchments show head cutting and vertical incision. (See photographs 4 and 5.) Catchment N-4 does not show channel incision but has deposition in some areas.

Photograph 4. Channel with head cutting or scour hole downstream of channel.

Constraints of
Habitat and Channel Stability on the Development of
Drainage Improvement Alternatives for the S-1 to S-3 and N-1 to N-5 Urban Planning Zones

Photograph 5. Channel with vertical incision.

4.0 POTENTIAL CHANGES DUE TO FUTURE DEVELOPMENT

Urbanization of any catchment will affect and potentially degrade the channels in that catchment. These changes stem from the changes in hydrology caused by urbanization. The extent of the changes in hydrology is dependent on the percentage imperviousness of the area developed, type of development, structural mitigation measures used (such as stormwater detention), and nonstructural measures used (such as buffer zone protection and wetlands protection). Hydrologic changes that often occur with development of a catchment are listed below.

1. The base flow in a catchment is often increased by urbanization.

2. Small storm events (less than the 2-year event) that infiltrate into the soil in the undeveloped condition can yield runoff after development. The frequency of runoff events is, therefore, increased. The volume of runoff from these events is also markedly increased after urbanization.

3. Channel forming flows (generally the 2-year event) will increase after urbanization.

4. Major event storm flows (10-year and larger events) will increase due to urbanization.

The increase in channel-forming flows and the increase in frequency and volume of smaller runoff events are the storm events that will have the greatest effect on stream channel stability. Increase in base flow will have significant effects (positive and negative) on stream habitat and aquatic life. The increase in major event storm flows will affect the flooding potential of the streams.

Natural stream channels attain a stable longitudinal slope depending on the type of bed material and magnitude of flows in the channel. The higher the flows or the smaller the bed material, the flatter the longitudinal slope of the channel must be to maintain stability. During urbanization of any of the subject catchments, storm flows in the streams will increase as described above. The increase in flow will reduce the stable longitudinal slope of the streams in the catchment. The streams will reach a new stable longitudinal slope that is flatter that the one that was dependant upon historic condition storm flows. This will result in streambed erosion (incision) that often starts at the downstream end of the stream at a control point that has a stable (or relatively stable) bottom elevation (such as the Salt Creek or a culvert with a headwall). The erosion proceeds upstream forming a "head cut" (discontinuity) at the upstream end of the erosion. The head cut gradually migrates upstream until another control point is reached. The upstream control point can be a layer of rock or competent soil or a constructed facility such as a grade control structure.

Streambed incision causes a gradual channel widening. The incision results in the channel side slopes becoming steeper. If the channel banks become too steep to be stable, they will gradually slough in order to achieve a flatter slope. This sloughing will result in a gradual widening of the

channel until a stable channel cross section is reached. Resulting sediment can become a problem downstream as deposition.

The longitudinal bed slope and bank slope of a channel can be influenced by constructed facilities in the channel. For example, a culvert can start a head cut if it is placed too low. This has happened in small tributaries in the N-3 catchment. A culvert can also stop a head cut from below from progressing farther upstream. A constructed channel can set a new control point elevation for tributary streams.

Changes in streambed longitudinal slope or channel widening will result in changes in riparian vegetation and stream habitat. Riparian vegetation will be lost to erosion until a new stable channel configuration is reached.

5.0 ALTERNATIVE DRAINAGE IMPROVEMENTS

This section provides a framework for the development, review and analysis of alternative drainage improvement scenarios with respect to channel stability and stream habitat. The key goals for preparation of alternatives are:

1. Reduce post-development flow rates through the use of detention.

2. Develop stable channel longitudinal slopes.

3. Provide wide riparian buffer strips adjacent to channels.

4. Monitor stream channel bed slope and cross section changes over time.

5. Use new channel construction and/or rehabilitation as an opportunity to improve habitat.

As development occurs in any area of either of the watersheds, detention should be provided for the water quality storm (0.5-inch storm), 2-yr, 10-yr and 100-yr storms as per section 6.4.2 of the